



Nordic nRF52840 BLE v5.0 RF Test

Application Note

20180322

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1. Nordic nRF52840 DTM(Direct Test Mode) Test

1.1 Introduction

The main function of a production test is to verify that all the components are mounted correctly and have correct values after assembling a device.

To perform a production test on a Bluetooth® low energy application, it is preferable to use a built-in function called Direct Test Mode (DTM). The DTM enables testing of the RF parameters and is also used for end-product qualification testing of the RF physical layer (RF PHY). Bluetooth low energy products of Nordic include a UART interface that gives access to the Direct Test Mode (DTM).

The DTM has two main modes of operation; the transmit test mode and the receive test mode. In transmit test mode, the Device Under Test (DUT) generates a predefined set of test packets. In receive test mode, the DUT counts the number of test packets received.

This application note describes for RF test by using TC-3000C Bluetooth test set in DTM mode

1.2 Setup

TC-3000C supports Bluetooth low energy (BLE) DTM testing on a device by controlling the device through the HCI or two-wire (UART) interface while measuring the RF performance. The 2-Wire UART interface is available on all Nordic Semiconductor BLE devices. TC-3000C can run BLE tests directly, or the testing can be controlled from a computer.

The DUT is controlled by sending DTM commands over the 2 Wire UART interface.

1.2.1 Setting up hardware for BLE v5.0 DTM test

- DUT: The DTM firmware must be downloaded
- From the back of the TC-3000C connect the Data cable through a transceiver and level shifter to the UART pins on the motherboard:
- Connect the RF cable between the DUT and TC-3000C
- Attenuator: The RF output power range of TC-3000C is 0 to -80 dBm. In order to transmit lower power below -80 dBm, the additional 30 dB Attenuator should be attached. (G99923A, 30 dB Attenuator will be provided) Attenuator being used, Path Loss must be input to the TC-3000C by Attenuator value. (Refer to TC-3000C Setup for setting Path Loss, 1.2.2 TC-3000C Setup)

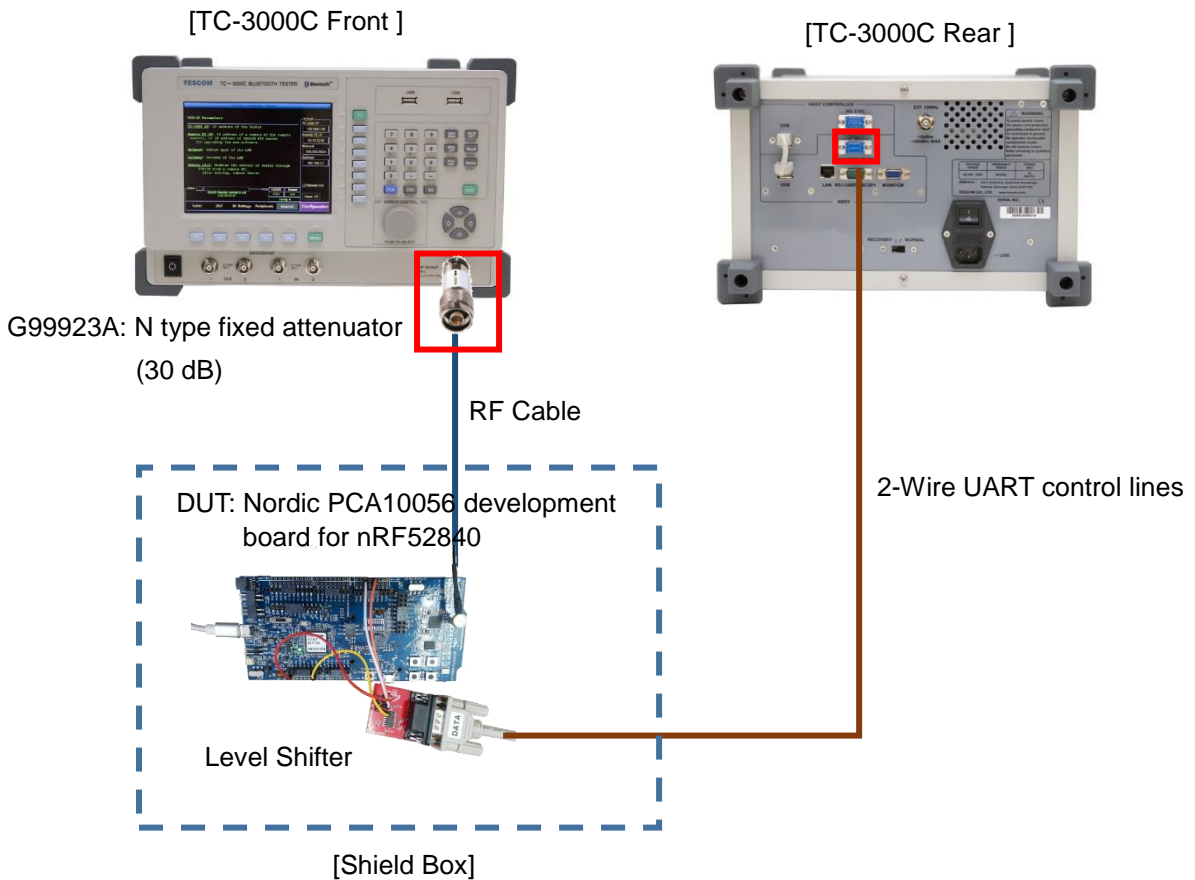
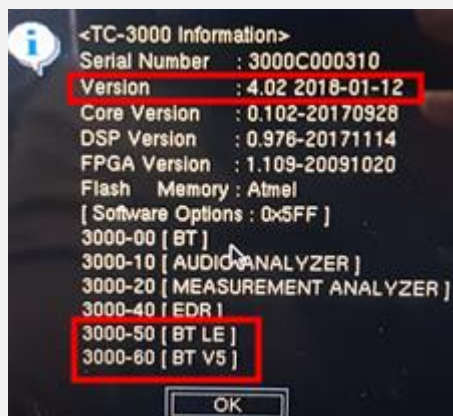


Figure 1-1 Direct Test Mode System Connection (nRF52840 Development Board)

1.2.2 TC-3000C Set up

NOTICE

To test Bluetooth v5.0, TC-3000C S/W option "3000-50 BT LE" and "3000-60 BT V5" should be installed and TC-3000C Firmware Version should be v4.00 or higher. If the 3000-50 option is included, only 3000-60 BT V5 can be purchased.



1. BT LE Mode Setup

- Select MENU -> Configuration -> DUT(M2) -> DUT Type(F2) -> BT LE

NOTICE

After TC-3000C Firmware Version 4.00, it will take less than 10 seconds to switch from BT to BT LE mode.

2. HCI Port Setup: Set up the HCI port for DUT.

- Select MENU -> Configuration -> DUT(M2) -> (F3) -> 2WIRE2

NOTICE

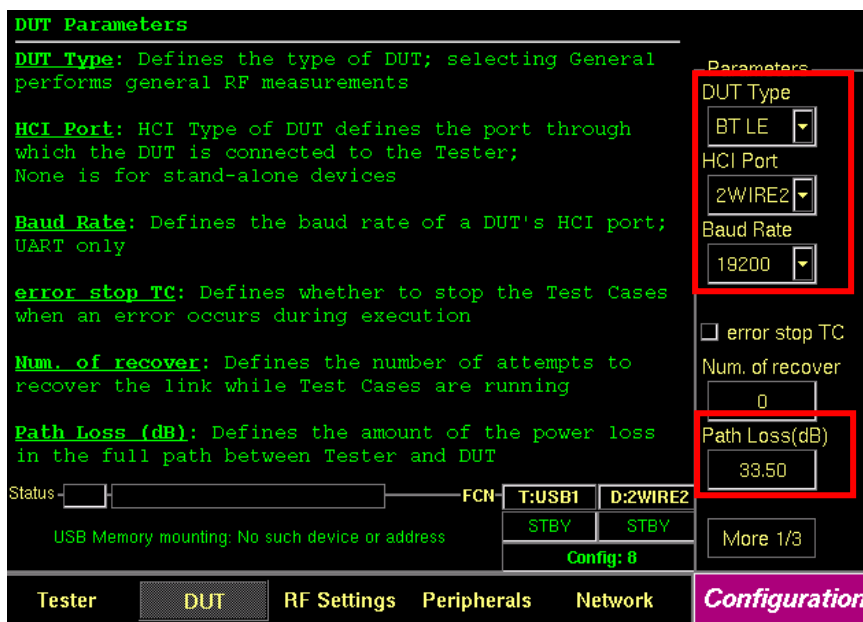
When setting up the HCI port, use 2WIRE2 because the 2WIRE1 port is used for PC remote programs.

3. Baud Rate Setup: Set up the Baud rate for DUT.

- Select Menu -> Configuration -> DUT (M2) -> Baud Rate (F4) and set 19200.

4. Path Loss Setup

- Menu -> Configuration -> DUT (M2) -> Path Loss (F7)
- Measure path loss from TC-3000C to DUT.

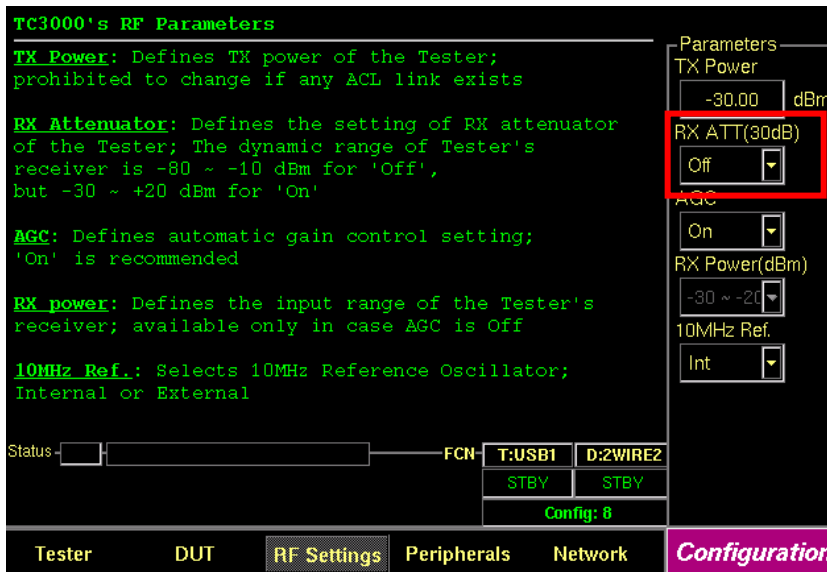


CAUTION

Attenuator being used, Path Loss must be input to the TC-3000C by Attenuator value.

5. Input Level Setup

- Defines the input range of the Tester
- Menu -> Configuration -> RF Settings (M3) -> RX ATT (F3) -> Off
 - RX ATT option must be set to 'Off' for using the 30 dB Attenuator, G99923A
 - Preset, the RX ATT (30dB) value is set to ON

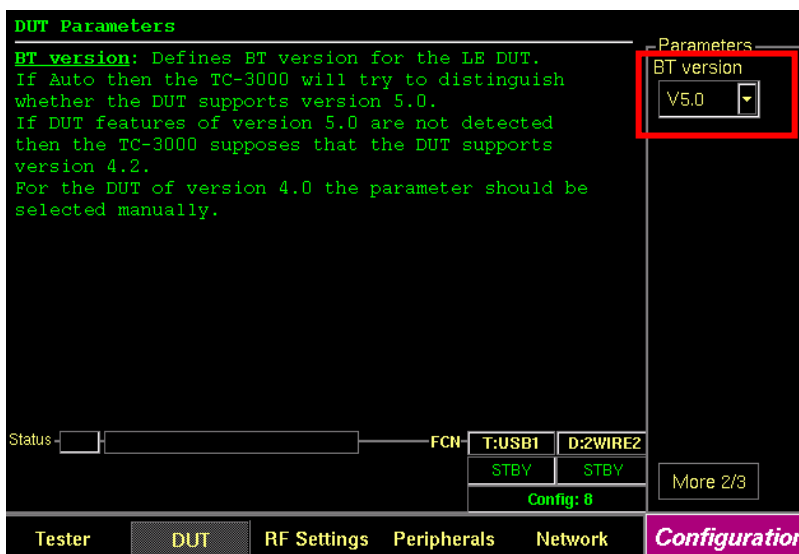


CAUTION

Defines the setting of the RX attenuator of the Tester;
 The dynamic range of Tester's receiver is -80 ~ -10 dBm for 'On'(Defaulted value),
 -30 ~ +20 dBm for 'Off'

6. BT version Select

- MENU -> Configuration -> DUT -> BT version(F2) -> 5.0 version Select
- Set to "Auto", TC-3000C determines whether the DUT supports BT v5.0. If not, the TC-3000C will work with v4.2.



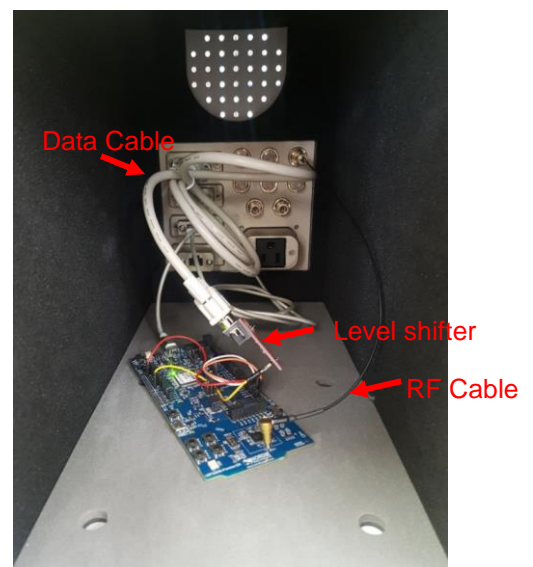
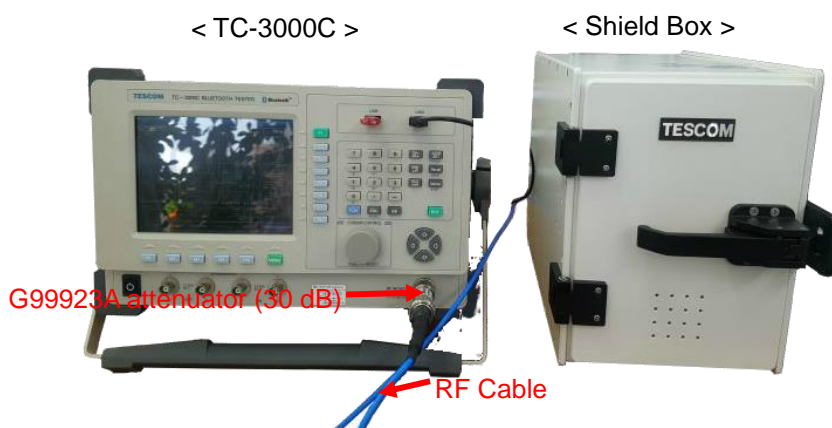
CAUTION

BT version setting menu is available from the TC-3000C firmware version v4.00 or later

1.3 Test Procedure

1. Set up the RF test environment (See 1.2.1 Set up)

[Front View]



[Shield Box Inner View]

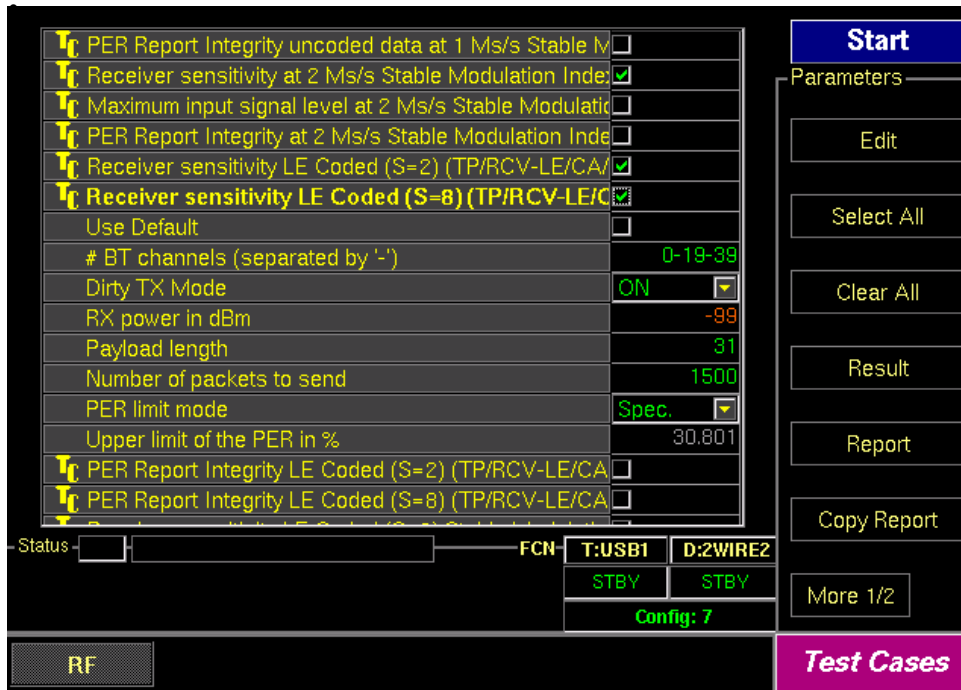
[Rear View]



2. Set up the TC-3000C. (See 1.2.2 TC-3000C Set up)

3. Select the RF test cases.

- Select Menu -> Test Cases and test items. (Rotate and press the rotary encoder.)
- Select **Edit** to check the test conditions and edit according to the test conditions.
- Refer to TC-3000C BLE User's Manual for test items and specifications.



4. Test Start: **Start** Select the Start key.

5. Test Result Checking

- Check the result or report.
- If necessary, save the result to USB by clicking the **Copy Report** button.

2. Appendix. Test Result

9 RF test cases started: Thu Mar 22 09:50:29 2018

_____ Output Power (TP/TRM-LE/CA/BV-01-C)

Initial conditions:

Hopping: off
 Payload: PRBS 9
 Payload's length: 37 bytes
 Num. of packets: 1
 Path losses: 33.50dB

Limits:

-20.00dBm <= Pavg <= 10.00dBm, Ppk-av <= 3.00dB

Results (power in dBm):

#ch	f(MHz)	Pavg	Ppk	Ppk-av	Pmin	Verdict
0	2402	0.31	0.43	0.12	0.14	PASSED
19	2440	0.31	0.43	0.12	0.15	PASSED
39	2480	0.3	0.42	0.12	0.13	PASSED

Test time: 4 sec.

_____ Receiver sensitivity (TP/RCV-LE/CA/BV-01-C)

Initial conditions:

Payload: PRBS 9
 Payload's length: 37 bytes
 Packets to transmit: 1500
 RX (DUT) power: -93.00dBm
 Path losses: 33.50dB
 Dirty TX mode: On
 PER limit mode: Specification
 Power step period: 1000ms

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict
0	2402	1500	1118	25.467	PASSED
19	2440	1500	1260	16	PASSED
39	2480	1500	1112	25.867	PASSED

Test time: 4 sec.

Receiver sensitivity at 2 Ms/s (TP/RVC-LE/CA/BV-08-C)

Initial conditions:

Payload: PRBS 9
 Payload's length: 31 bytes
 Packets to transmit: 1500
 RX (DUT) power: -91.00dBm
 Path losses: 33.50dB
 Dirty TX mode: On
 PER limit mode: Specification
 Power step period: 1000ms

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict
0	2402	1500	1201	19.933	PASSED
19	2440	1500	1218	18.8	PASSED
39	2480	1500	1080	28	PASSED

Test time: 4 sec.

Receiver Sensitivity uncoded data at 1 Ms/s Stable Modulation Index (TP/RVC-LE/CA/BV-14-C)

Initial conditions:

Payload: PRBS 9
 Payload's length: 37 bytes
 Packets to transmit: 1500
 RX (DUT) power: -93.00dBm
 Path losses: 33.50dB
 Dirty TX mode: On
 PER limit mode: Specification
 Power step period: 1000ms

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict
0	2402	1500	1239	17.4	PASSED
19	2440	1500	1382	7.867	PASSED
39	2480	1500	1221	18.6	PASSED

Test time: 4 sec.

_____Receiver sensitivity at 2 Ms/s Stable Modulation Index (TP/RCV-LE/CA/BV-20-C)

Initial conditions:

Payload: PRBS 9
 Payload's length: 31 bytes
 Packets to transmit: 1500
 RX (DUT) power: -91.00dBm
 Path losses: 33.50dB
 Dirty TX mode: On
 PER limit mode: Specification
 Power step period: 1000ms

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict
0	2402	1500	1252	16.533	PASSED
19	2440	1500	1248	16.8	PASSED
39	2480	1500	1145	23.667	PASSED

Test time: 4 sec.

_____Receiver sensitivity LE Coded (S=2) (TP/RCV-LE/CA/BV-26-C)

Initial conditions:

Payload: PRBS 9
 Payload's length: 31 bytes
 Packets to transmit: 1500
 RX (DUT) power: -96.00dBm
 Path losses: 33.50dB
 Dirty TX mode: On
 PER limit mode: Specification
 Power step period: 1000ms

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict
0	2402	1500	1324	11.733	PASSED
19	2440	1500	1373	8.467	PASSED
39	2480	1500	1247	16.867	PASSED

Test time: 7 sec.

Receiver sensitivity LE Coded (S=8) (TP/RCV-LE/CA/BV-27-C)

Initial conditions:

Payload: PRBS 9
 Payload's length: 31 bytes
 Packets to transmit: 1500
 RX (DUT) power: -99.00dBm
 Path losses: 33.50dB
 Dirty TX mode: On
 PER limit mode: Specification
 Power step period: 1000ms

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict
0	2402	1500	1253	16.467	PASSED
19	2440	1500	1177	21.533	PASSED
39	2480	1500	1038	30.8	PASSED

Test time: 15 sec.

Receiver sensitivity LE Coded (S=2) Stable Modulation Index (TP/RCV-LE/CA/BV-32-C)

Initial conditions:

Payload: PRBS 9
 Payload's length: 31 bytes
 Packets to transmit: 1500
 RX (DUT) power: -93.00dBm
 Path losses: 33.50dB
 Dirty TX mode: On
 PER limit mode: Specification
 Power step period: 1000ms

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict
0	2402	1500	1138	24.133	PASSED
19	2440	1500	1349	10.067	PASSED
39	2480	1500	1493	0.467	PASSED

Test time: 7 sec.

Receiver sensitivity LE Coded (S=8) Stable Modulation Index (TP/RCV-LE/CA/BV-33-C)

Initial conditions:

Payload: PRBS 9
 Payload's length: 31 bytes
 Packets to transmit: 1500
 RX (DUT) power: -99.00dBm
 Path losses: 33.50dB
 Dirty TX mode: On
 PER limit mode: Specification
 Power step period: 1000ms

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict
0	2402	1500	1253	16.467	PASSED
19	2440	1500	1219	18.733	PASSED
39	2480	1500	1038	30.8	PASSED

Test time: 15 sec.

9 RF test cases completed: Thu Mar 22 09:51:34 2018

Total test time: 1 min. 5 sec.